Methods

Identification of the Scalp Regions of Interest

In order to determine Scalp Regions of Interests (S-ROIs), for each time intervals and frequency bands, the "responsive electrodes" were identified on the basis of the group-mean topographical maps obtained from the spectral analysis and reported in Figure 2 A of the paper. An electrode was defined as "responsive" if it showed intense power perturbation in comparison to the baseline period. After the identification of the responsive electrodes, the selections of the two experiments were compared and the S-ROIs edges were defined. This was also guided by the data reported previously published on reaching (Babiloni et al. 1999; Bernier et al. 2009; Naranjo et al. 2007). Finally, for the selected electrodes, we checked whether they showed significant variation of power with respect to the baseline period in any of the time intervals and frequency ranges by using a statistical nonparametric mapping procedure (SnMP, simple-threshold, $p = 0.05$). To do so, we computed paired sample t-test at channels level between the condition of interest and the baseline. Significance was determined on the basis of permutation test (Nichols and Holmes 2002) as described in previous works (Huber et al. 2006; Huber et al. 2004).

Event Related Spectral Perturbation

To investigate the impact of the baseline selection on the brain activation patterns and on the correlation findings, Event Related Spectral Perturbation (ERSP) estimation was computed on the same set of data by using the entire epoch as a baseline (1.5 s). All the remaining procedures were exactly the same as those described in the original manuscript.

Results

Temporal changes in EEG power through scalp locations and frequency bands. Figure 1 (supplemental material) shows the brain activation patterns across selected time windows and frequencies. As expected, in the Pre-Stim interval we observed synchronization over the centro-lateral sites for the alpha2 and beta bands. This increase was mostly evident at electrodes contralateral to the movement side. Movement planning and execution was accompanied by an increment of theta power over the centro-medial and –lateral electrodes in the period. As for the alpha and beta bands, we found attenuation of power during the execution of the movement that was seen bilaterally over the centro-lateral sites. However the desynchronization was greater for electrodes contralateral to the movement side. Beta also showed power decrease over the frontal region.

Correlation analysis. When we correlated the activity for the selected time windows and frequency bands with kinematic indices, we observed some differences in comparison to the results obtained with the short baseline analysis. As expected, the main difference was the absence of correlation between beta activity and reaction times (Table 1, supplemental material). The results for the other correlations were similar to those reported in the original manuscript. Peak velocity and peak acceleration correlated with theta activity over posterior sites selectively in the stage of movement planning, while movement extent correlated with low alpha and theta during movement execution.

Discussion

This analysis captured the well-known alpha and beta synchronization activity following movement offset. Besides this main difference however, the patterns of power variation across time and frequency bands were similar to those reported in the manuscript.

The beta rebound might also partially explain the reported high coherent activity preceding stimulus appearance, which was interpreted as expression of attention modulation. However, our results suggest that the pre-stimulus beta coherence reflects, at least in part, the formation of transient neural assemblies responsible for efficient perception and motor performance through the modulation of attention. In fact, if the beta coherence decreases were a mere consequence of beta rebound, it should be most evident across the channel pairs with maximal post-movement power increase. This was not the case in our study: in fact, we observed long-range beta phase coupling that involved channels with minimal power variation induced by motor processes (Figure 2 and Figure 3 in the paper). In addition, we actually observed significant beta-1 increase in the planning stage between channels known to reflect maximally motor-related activity (C3, CP3, CZ, FC3; Figure 3).

As for the correlations, we did not observe the linear relation between reaction times and beta activity, which has been interpreted as the expression of the efficient disengagement from the “idle state” following movement execution. This phenomenon was canceled out when we used the entire epoch as reference. It is likely that the baseline selection might have worked as a zoom out by flattening the fast changes in brain dynamics that follow the beta and alpha rebound.

References

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Figure 1 Supplemental Material. Group-mean ERSP for the 5 selected frequency bands are plotted on the scalp at the different time intervals of interest. The ERSP was computed using the entire epoch as baseline.

Table1 Supplemental Material. Correlations between brain activity and behavioral indices for selected time windows and frequency bands (baseline: 1.5 s, entire epoch).